

CLAIMS

1 1. A supermolecular structure comprised of a host material and impurities such
2 that the positions of component atoms are substantially fixed to impart substantially
3 predictable properties to the structure, the structure also being described by the for-
4 mula:

$$H_A \sum X_{ia}$$

wherein:

H defines the host material;

A is a number representing the number of host atoms in the structure;

X defines the i^{th} impurity; and

a defines the quantity of the i^{th} impurity.

2. A pn junction formed from the supermolecular structure of claim 1.

3. The pn junction of claim 2 further comprising:

an insulating substrate on which the supermolecular structure is dis-
posed; and

contact electrodes connected to the supermolecular structure so that the
pn junction forms a stand-alone device.

1 4. A bipolar cell formed from the supermolecular structure of claim 1.

1 5. The bipolar cell of claim 4 further comprising:

2 an insulating substrate on which the supermolecular structure is dis-
3 posed; and

4 contact electrodes connected to the supermolecular structure so that the
5 bipolar cell forms a stand-alone device.

1 6. A single charge oscillator array comprising a plurality of electrostatically
2 coupled supermolecular structures, each structure further comprising a host material
3 and impurities such that the positions of component atoms are substantially fixed to
4 impart substantially predictable properties to the structure, each structure also being
5 described by the formula:

6 $H_A \sum X_{ia}$

7 wherein:

8 H defines the host material;

9 A is a number representing the number of host atoms in the structure;

10 X defines the i^{th} impurity; and

11 a defines the quantity of the i^{th} impurity.

1 7. A single-dopant pn junction comprising:

2 a host structure;

3 a single donor atom disposed at a first side of the host structure; and

4 a single acceptor atom disposed at a second side of the host structure,

5 the second side being opposite the first side, the single donor atom and single

6 acceptor atom being positioned so that a single dipole is created within the host

7 structure.

1 8. The single-dopant pn junction of claim 7 further comprising:

2 an insulating substrate on which the host structure is disposed; and

3 contact electrodes connected to the host structure so that the single-

4 dopant pn junction forms a stand-alone device.

1 9. A single-dopant bipolar cell comprising:

2 a host structure;

3 a pair of atoms of a first type disposed so that a single atom of the pair
4 resides at each of two opposing sides of the host structure; and

5 a single atom of a second type disposed between the atoms of the first
6 type within the host structure so that two asymmetrical potential wells, sepa-
7 rated by a barrier, are formed within the host structure.

1 10. The single-dopant bipolar cell of claim 9 wherein the first type of atom is an
2 acceptor and the second type of atom is a donor.

1 11. The single-dopant bipolar cell of claim 9 wherein the first type of atom is a
2 donor and the second type of atom is an acceptor.

1 12. A semiconductor device comprising:
2 an insulating substrate;
3 a host structure disposed upon the insulating substrate;
4 a pair of atoms of a first type disposed so that a single atom of the pair
5 resides at each of two opposing sides of the host structure;
6 a single atom of a second type disposed between the atoms of the first
7 type within the host structure so that two asymmetrical potential wells, sepa-
8 rated by a barrier, are formed within the host structure; and
9 contact electrodes connected to the host structure.

1 13. The semiconductor device of claim 12 wherein the first type of atom is an
2 acceptor and the second type of atom is a donor.

1 14. The semiconductor device of claim 12 wherein the first type of atom is a
2 donor and the second type of atom is an acceptor.

1 15. A single charge oscillator array comprising a plurality of electrostatically
2 coupled, single-dopant bipolar cells, each cell further comprising:

3 a host structure;

4 a pair of atoms of a first type disposed so that a single atom of the pair
5 resides at each of two opposing sides of the host structure; and

6 a single atom of a second type disposed between the atoms of the first
7 type within the host structure so that two asymmetrical potential wells, sepa-
8 rated by a barrier, are formed within the host structure.

1 16. A semiconductor oscillator comprising:

2 an insulating substrate;

3 a single charge oscillator array disposed upon the insulating substrate;

4 contact electrodes connected to the array; and

5 a thermal energy supply system for maintaining an operating tempera-
6 ture of the array at least as high as a threshold temperature.

17. The semiconductor oscillator of claim 16 wherein the single charge oscillator array further comprises a plurality of electrostatically coupled supermolecular structures, each structure further comprising a host material and impurities such that the positions of component atoms are substantially fixed to impart substantially predictable properties to the structure, each structure also being described by the formula:

$$H_A \Sigma X_{ia}$$

wherein:

H defines the host material;

A is a number representing the number of host atoms in the structure;

X defines the i^{th} impurity; and

a defines the quantity of the i^{th} impurity.

18. The semiconductor oscillator of claim 16 wherein the single charge oscillator array further comprises a plurality of electrostatically coupled, single-dopant bipolar cells, each cell comprising:

a host structure;

a pair of atoms of a first type disposed so that a single atom of the pair resides at each of two opposing sides of the host structure; and

a single atom of a second type disposed between the atoms of the first type within the host structure so that two asymmetrical potential wells, separated by a barrier, are formed within the host structure.

1 19. Apparatus for supplying oscillations comprising:

2 means for supplying thermal energy to maintain an operating tempera-
3 ture of the apparatus at least as high as a threshold temperature;

4 means for generating coherent oscillations in response to the thermal
5 energy;

6 means for insulating and supporting the means for generating; and

7 means for connecting the apparatus to external circuitry, the means for
8 connecting connected to the means for generating.

1 20. A method of fabricating a single-dopant, bipolar cell on a substrate of a
2 semiconductor material, the method comprising the steps of:

3 placing a single three-atom set of dopants on the substrate;

4 growing an epitaxial film of the semiconductor material over the set of
5 dopants and the substrate; and

6 passivating the cell with at least one monolayer.

1 21. The method of claim 20 wherein the three-atom set of dopants is placed by
2 a proximity probe manipulation technique.

1 22. A method of fabricating a plurality of single-dopant bipolar cells on a sub-
2 strate of a semiconductor material, the method comprising the steps of:

3 placing two or more single three-atom sets of dopants on the substrate;

4 growing an epitaxial film of the semiconductor material over the sets of
5 dopants and the semiconductor substrate;

6 producing a pattern at the surface of the epitaxial film, the pattern defin-
7 ing a shape for the cells; and

8 passivating the plurality of single-dopant bipolar cells with at least one
9 monolayer.

1 23. The method of claim 22 wherein the three-atom sets of dopants are placed
2 by a proximity probe manipulation technique.

1 25. A method of fabricating a single-dopant bipolar cell by forming a vertical,
2 three-atom set of dopants, the cell being formed on a substrate of semiconductor ma-
3 terial, the method comprising the steps of:

4 placing a first atom of a first type on the substrate;

5 growing a first epitaxial film of the semiconductor material over the first
6 atom and the substrate;

7 placing a single atom of a second type atop the first epitaxial film;

8 growing a second epitaxial film of the semiconductor material over the
9 single atom of the second type and the first epitaxial film;

10 placing a second atom of the first type atop the second epitaxial film so
11 that the three-atom set is formed;

12 growing a third epitaxial film of the semiconductor material over the sec-
13 ond atom of the first type and the second epitaxial film; and

14 passivating the cell with at least one monolayer.

1 26. The method of claim 25 wherein the first atom of the first type, the single
2 atom of the second type, and the second atom of the first type are all placed by a
3 proximity probe manipulation technique.

1 27. A method of fabricating an plurality of single-dopant bipolar cells by forming
2 vertical, three-atom sets of dopants, the cells being formed on a substrate of semicon-
3 ductor material, the method comprising the steps of:

4 placing two or more first atoms of a first type on the substrate;

5 growing a first epitaxial film of the semiconductor material over the first
6 atoms of the first type and the substrate;

7 placing a plurality of single atoms of a second type atop the first epitaxial
8 film;

9 growing a second epitaxial film of the semiconductor material over the
10 single atoms of the second type and the first epitaxial film;
11 placing a plurality of second atoms of the first type atop the second epi-
12 taxial film so that three-atom sets are formed;
13 growing a third epitaxial film of the semiconductor material over the sec-
14 ond atoms of the first type and the second epitaxial film;
15 producing a pattern at the surface of the third epitaxial film, the pattern
16 defining a shape for the cells; and
17 passivating the plurality of single-dopant bipolar cells with at least one
18 monolayer.

1 28. The method of claim 27 wherein the first atoms of the first type, the single
2 atoms of the second type, and the second atoms of the first type are all placed by a
3 proximity probe manipulation technique.